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EVALUATION OF ELECTRIC PRESSURE FRYERS

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Army Natick Laboratories
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13. ABSTRACT <p>This report covers the evaluation of commercial electric pressure fryers to determine if the pressure frying method of cooking is superior to the deep fat frying method currently used in military food service facilities. The four phases evaluated were (1) engineering, (2) food production, (3) food acceptance, and (4) human factors.</p> <p>The pressure fryers have the following deficiencies:</p> <p>a. Model A. Cold zone area temperature at bottom of well is too high 161.2°C (322°F) causing carbonization of food particles on bottom which contributes to off-flavors in the frying medium. b. Model A. Water was injected from the injection system into the kettle while the lid was raised allowing hot fat to splatter on the operator. c. Model B. The fryer lid could be raised before zero pressure was attained causing hot fat to splatter on the operator. d. Models A and B. Hot fat splattered on the operator while placing single pieces of food into the cooking basket. e. Time consumed during the loading of food products is considered excessive. f. Cost of the pressure fryer is approximately five times that of a comparable capacity open deep fat fryer.</p> <p>The existing method of deep fat frying foods in a conventional fryer is equal to or better than utilizing pressure frying equipment. Pressure frying should not be utilized in military food service facilities.</p>		

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FRYING		4				
DEEP FAT FRYING		4				
PRESSURE FRYING		4				
MILITARY FEEDING		1				
GARRISON FEEDING		4				

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FOREWORD

The DoD Food Service Facility and Equipment Planning Board requested the U. S. Army Natick Laboratories to evaluate commercial, electric, pressure fryers. Objective of the evaluation was to determine if the pressure frying method is superior to the deep fat frying method currently being used in military kitchens and snack bars.

Acknowledgment is given to the Food Service Equipment and Evaluation Team, Food Systems Equipment Division, General Equipment & Packaging Laboratory and to Behavioral Sciences Division, Pioneering Research Laboratory for their support during the evaluation.

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EVALUATION OF ELECTRIC PRESSURE FRYERS

INTRODUCTION

The evaluation was conducted using two commercial electric, pressure fryers (hereinafter referred to as Model A^a (Figures 1, 2, and 3) and Model B^b (Figures 4, 5, 6, and 7)) and a commercial deep fat fryer^c. Photographs of the fryers are shown in Appendix A. The evaluation was initiated in order to determine whether the pressure frying method of cooking is superior to the deep fat frying method and if so whether it should be recommended for use in short order facilities, specialty houses and/or garrison food service facilities. Pressure frying of food products is accomplished by covering a fat fryer well with an air-tight lid so the moisture generated from the cooking process will assist in cooking the products under pressure. Frying is normally accomplished at lower than standard cooking temperatures, and it is claimed by manufacturers that cooking time is reduced 25 to 45 per cent. Manufacturers of the pressure frying equipment also claim food products prepared in such equipment retain a greater amount of moisture, thereby increasing yield, quality, and holding time.

MANUFACTURERS' DATA

MODEL A: The Model A pressure fryer has a deep circular cooking well with a fat capacity of 20.39 kg (45 lbs). The fryer measures approximately 41.6 cm (24-1/2 in.) wide by 84.46 cm (33-1/4 in.) deep by 134.6 cm (53 in.) high and 91.44 cm (36 in.) from floor to counter. The fryer has a food capacity of 5.08 kg (9 lbs) of chicken pieces. The fryer has National Sanitation Foundation and Underwriters' Laboratories approval. The fryer is designed for operation on a 208-volt, 60-Hertz, 3-phase, alternating current power supply.

MODEL B: The Model B pressure fryer has a deep rectangular cooking well with a fat capacity of 20.39 kg (45 lbs). The fryer measures 45.72 cm (18 in.) wide by 93.98 cm (37 in.) deep by 162.56 cm (64 in.) high and 83.19 cm (49 in.) from floor to counter. The fryer has a food capacity of 6.34 kg (14 lbs) of chicken pieces. The fryer has National Sanitation Foundation and Underwriters' Laboratories approval. The fryer is designed for operation on a 208-volt, 60-Hertz, 3-phase, alternating current power supply.

^aThe Broaster Co., Rocton, Illinois, Model 14E

^bThe Henry Penny Corp., Eaton, Ohio, Model 500

^cWells Manufacturing Corp., San Francisco, California, Model F-88

PROCEDURE

The engineering evaluation consisted of determining the electrical, thermal, and functional characteristics of the pressure fryers. Appendix B gives a list of areas that were tested. The tests were conducted utilizing the data furnished by the manufacturers as a guide.

The food production evaluation consisted of determining the different types of food that could be cooked, the theoretical production rate, the actual production rates and yields, and the temperature distribution in the fat during the cooking process. Sanitation was also considered in this phase. Appendix C gives a complete list of the areas that were tested. Like the engineering tests, the food production evaluation utilized the data provided by the manufacturer as a guide. Pressure fryer capacity was compared with the capacity of conventional deep fat fryers covered by Federal Specification S-F-695.

The food acceptance evaluation consisted of determining the consumer preference of chicken breasts and thighs fried in a conventional open fryer versus a pressure fryer. Appendix D gives a complete description of the test procedures and results.

The human factors evaluation consisted of determining the potential hazards and difficulties that an operator may have with the equipment. Appendix E gives a complete description of this evaluation.

INSTRUCTIONS FOR OPERATION OF EQUIPMENT

Model A

1. Place fry basket in preheated shortening in well.
2. Carefully place food products into basket. Load one piece at a time in a circular pattern.
3. Swing lid over well. Engage the locking post.
4. Set timer and turn timer power on. Water injection should be used for loads less than 1.36 kg (3 lbs).

5. At completion of fry cycle, buzzer will sound, and pressure will be released. When the pressure returns to zero, the lid may be opened. Lift basket from well with the wooden handle and let drain for 30 seconds.

Model B

1. Place fry basket in preheated shortening in well.
2. Carefully place food products into basket. Load one piece at a time in a circular pattern.
3. Close hinged lid and tighten until red knob is centered in front. Turn timer power switch on; timer is manually preset.
4. At completion of fry cycle, buzzer will sound and pressure will be released. When pressure returns to zero, lid may be opened.

DISCUSSION OF RESULTS

No major differences from either manufacturers' data were found during the engineering tests. The Model A pressure fryer's cold zone area temperature (bottom of well) was considered too high 161.2°C (322°F) because food particles on the bottom carbonized, contributing to off-flavors in the shortening. Three safety hazards were noted: Model A - (1) water was injected into the fryer while the lid was open (2) pressure exhaust manifold became very hot and Model B - (1) the lid could be opened before zero pressure was attained. In addition, the Model A fryer well does not have a mark to indicate proper fat level.

It was apparent from the results of the food production test that both pressure fryers are comparable to a conventional deep fat fryer between Federal Specification S-F-695, size 3 (sixty pounds production capacity*) and size 4 (ninety pounds production capacity*).

There were no problems encountered with the degree of doneness of the products. The major operational problem was that each piece of food product must be placed into the cooking basket separately causing the hot fat to splatter on the operator's hands. When the standard military procedure of placing a full load in the well at one time is used for loading the pressure fryer, the food products all stuck together. Placing each piece of food into the well separately

*Production capacity is defined as the quantity of raw potatoes prepared for French frying that can be properly processed per hour.

as recommended by the manufacturer was a time-consuming task. The major reason that the production capacity varied considerably was that the manufacturers did not take into account the time required to load the food and the time it takes for the pressure to vent before the lid may be opened. Very slight savings in product yield were derived with pressure frying. The moisture that was retained in the fat places an extra burden on the shortening because it can lead to a more rapid buildup of undesirable free fatty acids.

No significant preference differences between open and pressure fried chicken breasts or thigh pieces were found at the 95% confidence level.

The human factors evaluation emphasized the fact that pressure frying equipment can be hazardous to the operator. The placing of each piece of food into the fat was considered to be the most hazardous operation. The water injection system of the Model A fryer can be actuated with the lid opened allowing hot fat to spray on the operator. The lid on the Model B fryer can be opened prior to dropping to zero pressure causing fat to splatter, endangering the operator.

Following are the list prices of the pressure fryers and the comparable conventional fryers utilized by the military:

<u>Fryer</u>	<u>Cost</u>
* Model A	\$1,816.50
* Model B	1,625.00
Military Size 3 (FSN 7310-227-1744)	214.00
Military Size 4 (FSN 7310-944-2705)	327.00

*Cost reflects standard off-the-shelf units without the semi-automatic fat filtering systems, even though the Model B evaluated herein did have the filtering system.

It can readily be seen that the pressure fryers cost more than five times as much as the comparable military deep fat fryer.

CONCLUSIONS

The evaluation indicates conclusively that the pressure frying method of frying foods does not offer any significant advantages over the existing deep fat frying method. This was most obvious from the food products and food preference evaluations. Also, it should be noted that the relatively expensive pressure fryers evaluated need some design modifications to eliminate possible safety hazards.

APPENDIX A

Photographs of Evaluated Pressure Fryers

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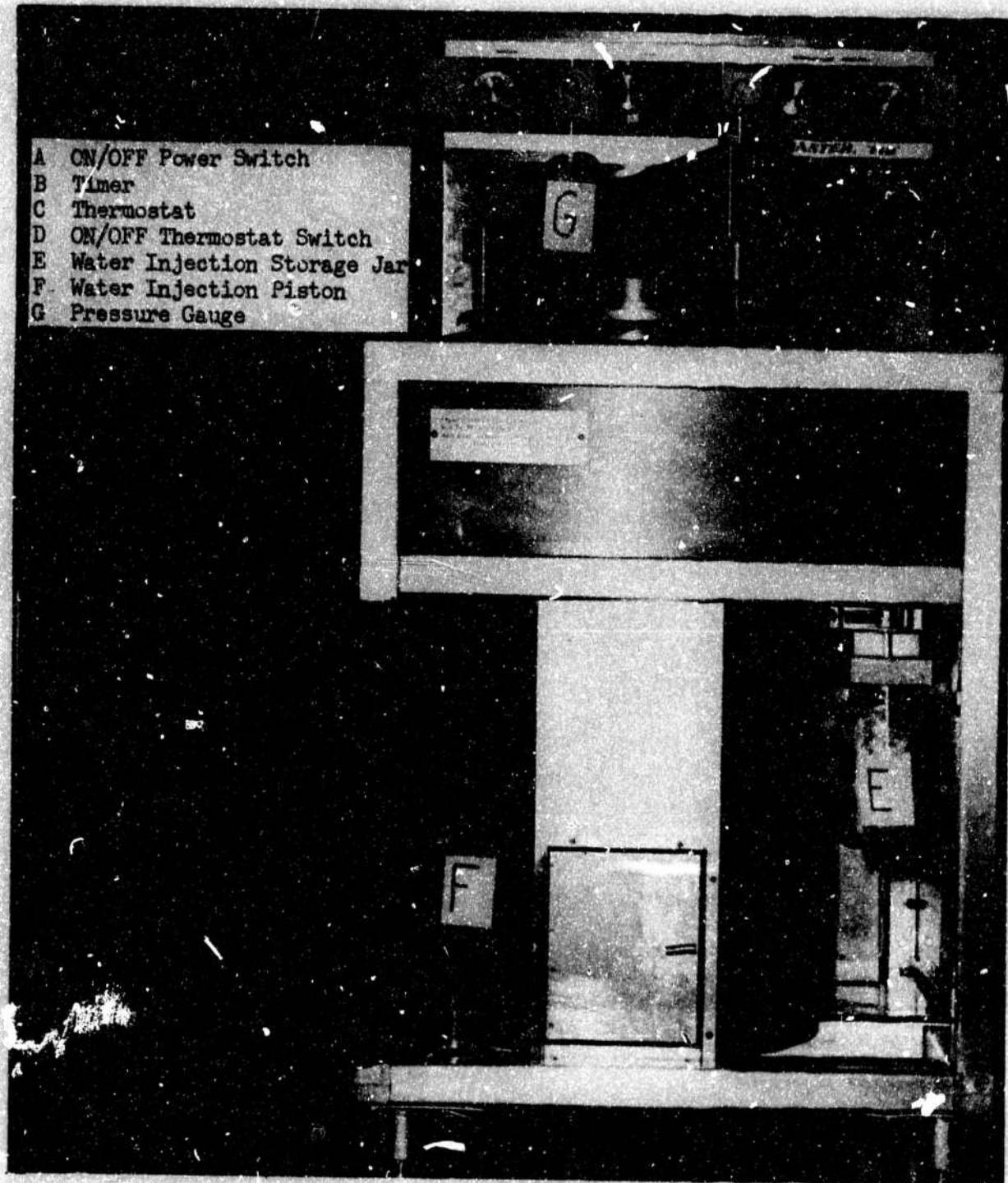
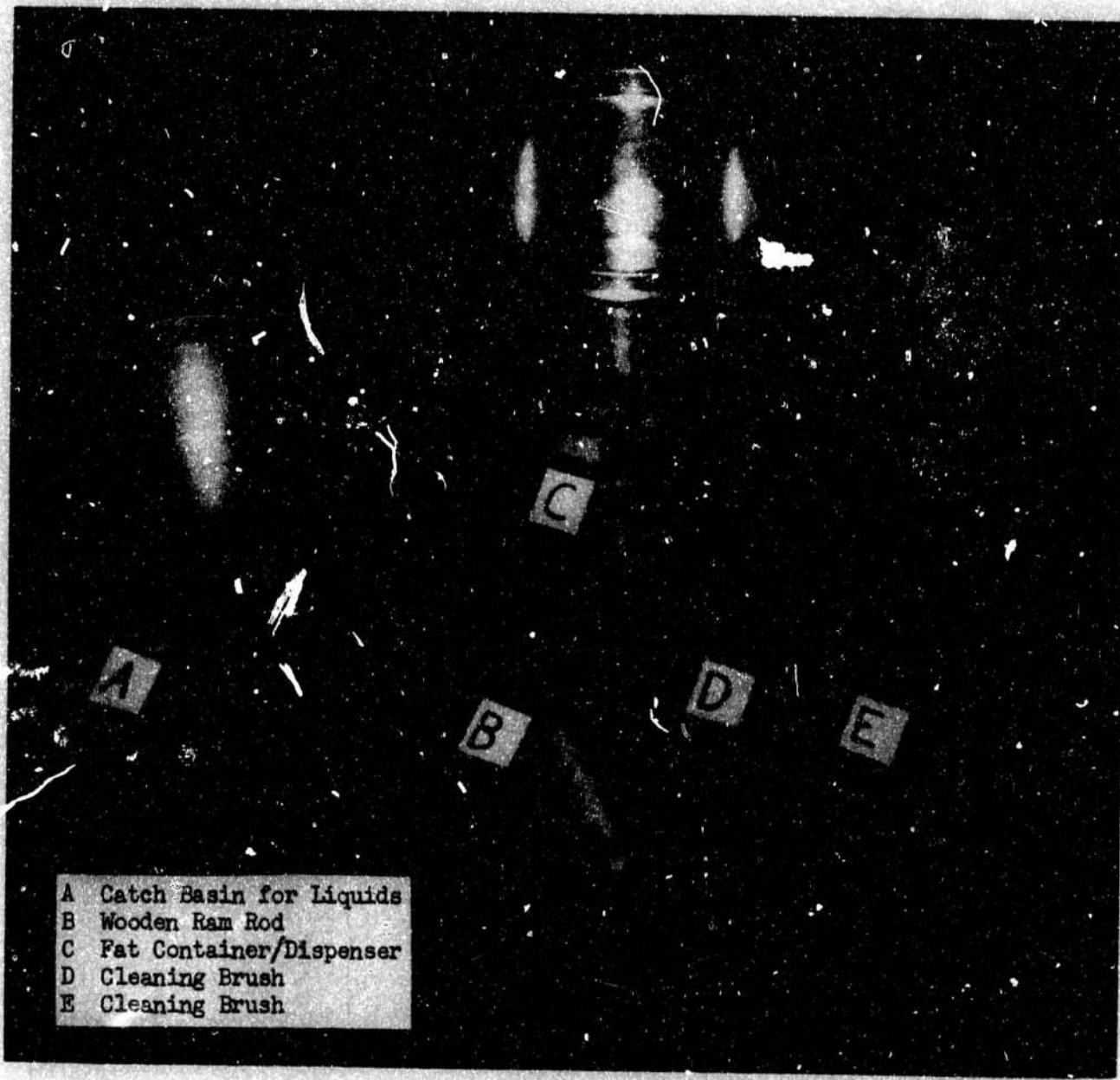


Figure 1. Pressure Fryer, Model A.

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- A Catch Basin for Liquids
- B Wooden Ram Rod
- C Fat Container/Dispenser
- D Cleaning Brush
- E Cleaning Brush

Figure 2. Drain Pans and Brushes, Model A.

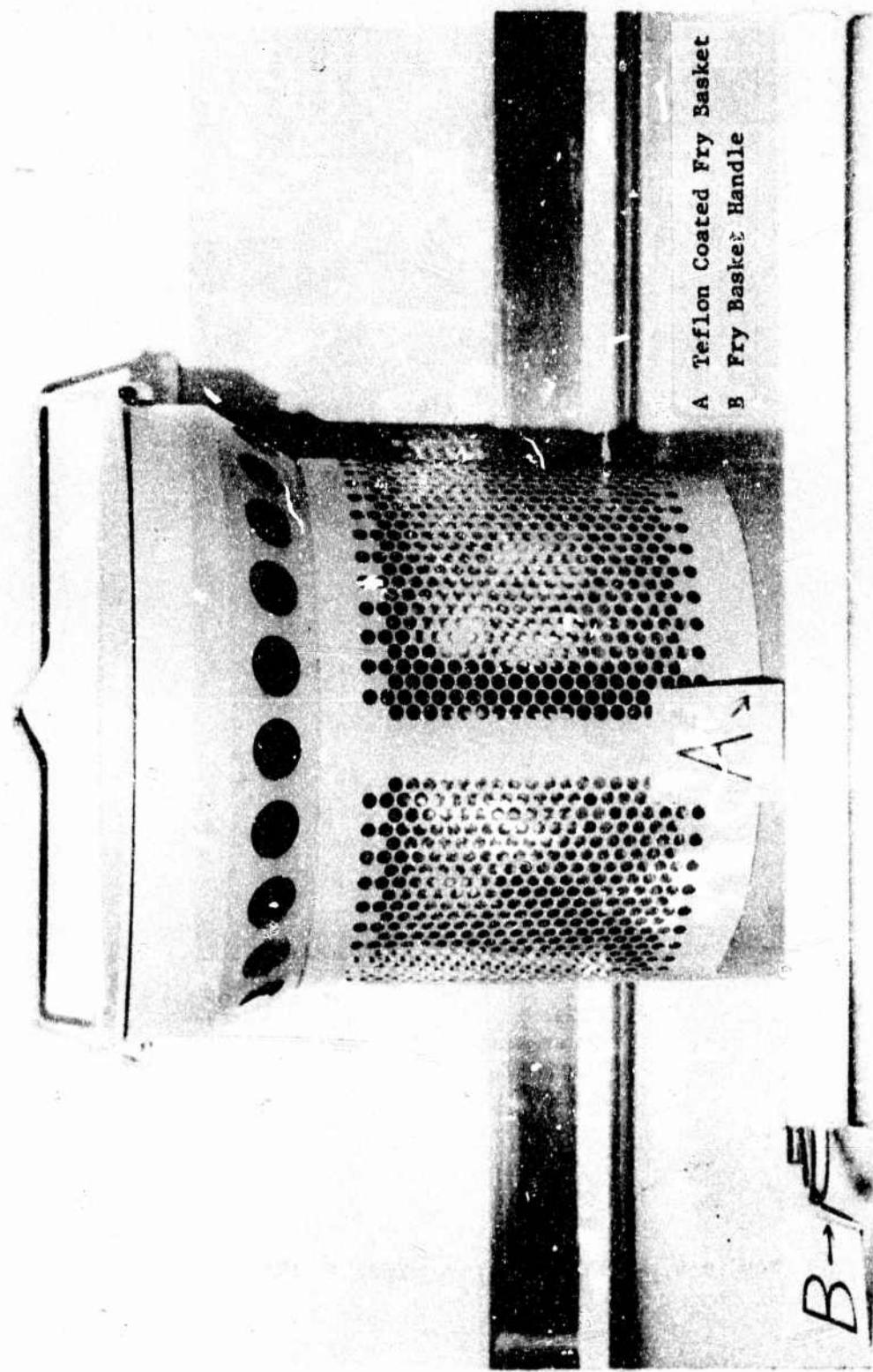
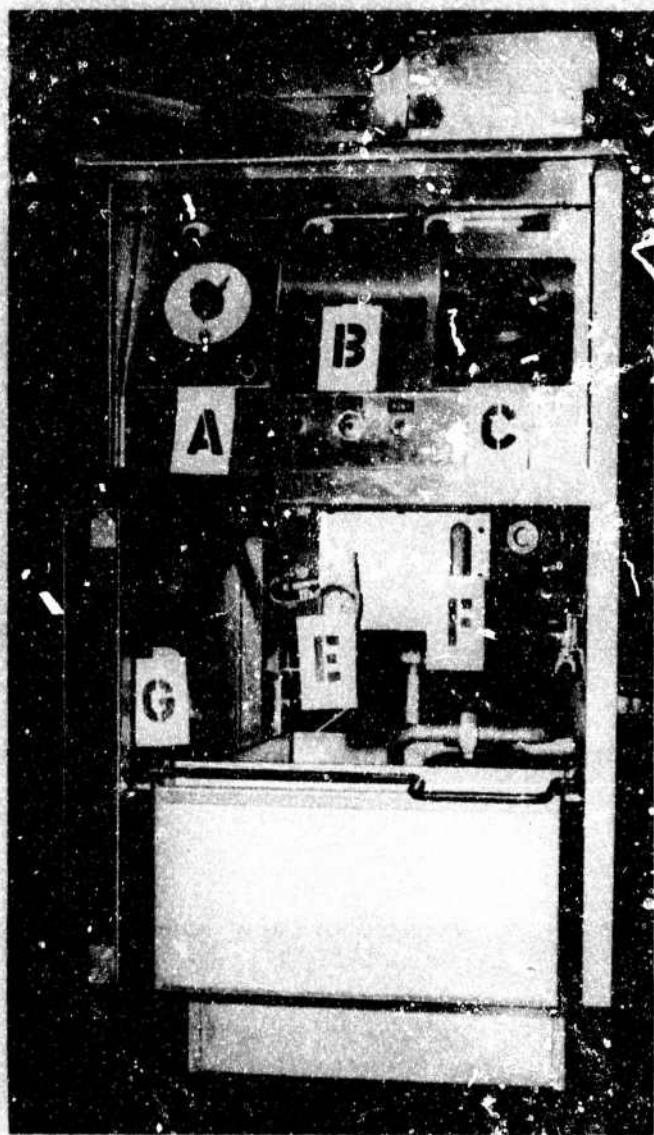


Figure 3. Fry Basket and Lifter, Model A.



- A Timer
- B Power-Pump ON/OFF Switch
- C Thermostat
- D Pressure Gauge

Figure 4. Pressure Fryer, Model B (Closed).



- A Timer
- B Power-Pump ON/OFF Switch
- C Thermostat
- E Drain Valve
- F Filtering System Control Valve
- G Drain Line for Liquids

Figure 5. Pressure Fryer, Model B (Open).



Figure 6. Fry Basket and Brushes, Model B.

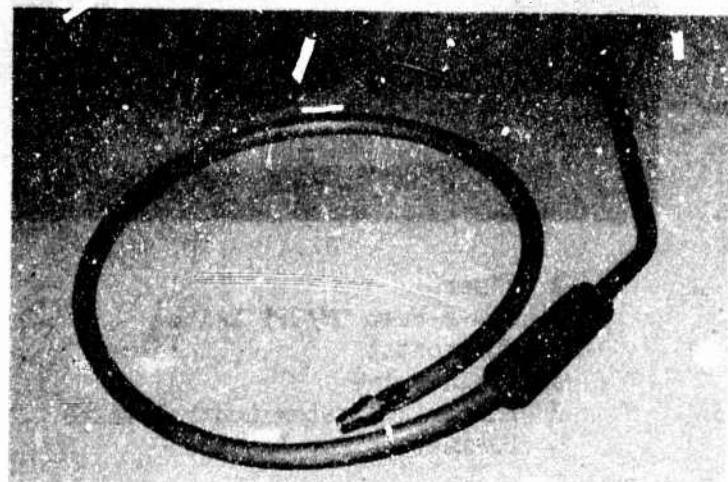


Figure 7. Filter Rinse Hose, Model B.

APPENDIX B

Engineering Evaluation Table

Engineering Evaluation of Pressure Fryers

<u>Engineering Data</u>	<u>Model A</u>	<u>Model B</u>
<u>Thermal Characteristics</u>		
Operating Temperature (Measured 2.54 cm (1 in.) Below Surface)	185°C (365°F)	162.8°C (325°F)
Operating Pressure	14 psig	9 psig
Heatup Time (Time to Reach Operating Temperature and to Melt Fat)	42 min	40 min
Cold Zone Temperature (Measured 2.54 cm (1 in.) Above Bottom of Well)	161.2°C (322°F)	140°C (284°F)
<u>Functional Characteristics</u>		
Thermostat Accuracy (At Operating Temperature)	±2.2°C (±4°F)	±2.2°C (±4°F)
Operation of Switches, Timers, Pilot Lights, Thermostats and Safety Valves	O.K.	O.K.

APPENDIX C

Food Production Evaluation

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Theoretical Production Capacity

The pressure fryer equipment is primarily used to cook chicken, therefore chicken was used as a guide to calculate the production rates.

	<u>Model A</u>	<u>Model B</u>
Basket Capacity	4.08 kg (9 lbs)	6.34 kg (14 lbs)
Cooking Time	7 min	9 min.
Production Rate	34.88 kg/hr (77 lbs/hr)	44.84 kg/hr (93 lbs/hr)

Food Products Tested

Both pressure fryers can be used to deep fat fry any product usually prepared in this manner. If moisture retention and speed in production are not needed, the lid can be left in the open position for frying.

The operating temperature and pressure of the fryers are as follows:

	<u>Model A</u>	<u>Model B</u>	<u>Conventional Fryer</u>
Operating Temperature	125°C (365°F)	162.8°C (325°F)	176.8°C (350°F)
Operating Pressure	14 psig	9 psig	N/A

Standard military procedures were used in all phases of the food production evaluation. When the baskets were filled with chicken or shrimp and placed in the frying vessel, the individual pieces of chicken or shrimp would adhere to each other during and after the cooking process. The pieces had to be placed piece by piece into the pressure fryer in order to prevent this sticking while the entire load could be placed into the conventional fryer at one time. This practice increased the total preparation time. Product was thawed first. The actual production cycle of a typical production batch of chicken is as follows:

	<u>Model A</u>	<u>Model B</u>	<u>Conventional Fryer</u>
Load	2 min. 15 sec.	2 min. 30 sec.	1 min.
Cook	8 min.	9 min.	11 min.
Vent	50 sec. 11 min. 5 sec.	45 sec. 12 min. 15 sec.	N/A 12 min.

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The following food products were tested to determine their production capacity and yield (includes load and vent times):

	<u>Model A</u> Production Rate	<u>Yield</u>	<u>Model B</u> Production Rate	<u>Yield</u>
Chicken pieces, refrigerated	22.19 kg/hr (49 lbs/hr)	71.9%	31.26 kg/hr (69 lbs/hr)	76.1%
French fries, frozen (lid closed)	*		24.92 kg/hr (55 lbs/hr)	58.4%
(lid open)	*		21.29 kg/hr (47 lbs/hr)	52.9%
Breaded shrimp, frozen	26.73 kg/hr (59 lbs/hr)	76.9%	26.73 kg/hr (59 lbs/hr)	67.6%

*Fries floated out of the basket

The yields obtained from frying refrigerated chicken pieces in a conventional fryer are between 69% and 75%.

Fat temperature was measured in the center of the basket 1" below the surface of the fat. Full basket loads of refrigerated chicken pieces were fried.

<u>Fat Temperature</u>	<u>Model A</u>	<u>Model B</u>
Starting point	185°C (365°F)	162.8°C (325°F)
Low point	151.2°C (304°F)	134.5°C (274°F)
Ending point	169.5°C (337°F)	147.3°C (297°F)

It is suggested that fluid deep fry shortening be used instead of a plasticized shortening. The plasticized shortening solidifies in the filtering system (if one is employed) and inhibits the flow of shortening when it congeals.

It took approximately 30 minutes to clean each of the fryers tested in accordance with the manufacturers' instructions. It is recommended that the filter rinse hose of the Model A fryer not be used because it splatters the hot fat when it is in use. It took approximately one-half hour to completely change the fat in each of the fryers tested.

APPENDIX D

Food Acceptance Evaluation

MODEL A

1. This test was conducted to determine the acceptability, from a consumer viewpoint, of chicken breasts and thighs fried in a conventional open fryer versus a pressure fryer. For each sample, the attributes of appearance, tenderness, juiciness, flavor, and overall acceptability were evaluated.

2. Test requirements:

- a. Total number of samples: 2 each test.
- b. Number and type of judges: 36 consumers, each test.

c. Temperature at which served: Pieces reached an average internal temperature of 87.8°C (190°F) and were held during serving in covered steam table pans lined with paper towelling in an oven set at 93.3°C (200°F).

3. Sensory observations:

Code 01 - Conventional deep fat fryer
Code 02 - Pressure fryer

Test 1 (Breasts)

Code

01 Dark golden brown. Breading somewhat oily, but oil is bland. Very tender, moist, well done. Flavor typical of a high quality fried chicken.

02 Same color as 01. No oiliness, bland oil taste. Meat moist, but somewhat tough (less tender, overall, than 01).

Test 2 (Thighs)

Code

01 Juicy, slightly underdone in center. Meat not quite released from bone and slightly reddish. Was probably 71.1°C - 76.6°C (160°F - 170°F) in center. Typical flavor of deep fried chicken - good quality.

02 Uniformly juicy and moist, excellent product.

Overall: All pieces uniformly golden brown.

4. Taste Test Results:

(1) Chicken Breasts

<u>Code</u>	<u>Treatment</u>	<u>Mean Rating</u>	<u>Std Dev</u>
01	Conventional Fryer	7.2	1.3
02	Pressure Fryer	7.5	1.1

(2) Chicken Thighs

01	Conventional Fryer	7.6	1.1
02	Pressure Fryer	7.6	1.2

Statistical interpretation: At the 95% confidence level, there were no significant preferences in either test.

5. Panelists' Comments:

(1) Chicken Breasts

<u>Code</u>	<u>Good Flavor</u>	<u>Poor Flavor</u>	<u>Lacks Flavor</u>	<u>Dry</u>	<u>Tough</u>	<u>Others</u>
01	4	1	1	1	1	Too well done
02	2	0	1	5	3	Too crunchy, overdone

(2) Chicken Thighs

<u>Code</u>	<u>Good Flavor</u>	<u>Poor Flavor</u>	<u>Rancid Flavor</u>	<u>Others</u>
01	1	0	1	Very tender, too wet
02	3	1	1	Not done enough, stringy, greasy

6. Discussion:

Although 8 panelists commented on dryness and toughness of the pressure fried breasts (nearly 1 out of 4 people, assuming no persons gave both responses), the rating remained at a high level. The writer's experience with the end-product was that free water was present but was "squeezed out" of the tissue upon chewing; what remained was tough, dry, and chewy. No observations of dryness or toughness of the thighs were made by writer or panelists. This was not surprising, since this is inherently a more moist part of the chicken.

The experience with the breast pieces suggested that, from a strictly quality standpoint, the higher operating temperature of the Model A 182.2°C (360°F) versus 162.8°C (325°F) for Model B may have an adverse effect on "dryer" pieces such as the breast meat. This, however, was not supported by consumer attitudes expressed in this test. Rating levels of Model A pressure fried breasts were practically identical in the Flavor and Overall categories. Lack of variation in ratings also suggested that a fairly broad range of quality is highly acceptable.

MODEL B

1. This test was conducted to test the difference from a sensory viewpoint of the frying of chicken breasts and thighs in a conventional deep fat fryer versus a pressure fryer. For each sample, the attributes of appearance, tenderness, juiciness, flavor, and overall acceptability were evaluated using the hedonic scale.

2. Test requirements:

a. Total number of samples: 2 each test.

b. Number and type of judges: 36 consumers each test.

c. Temperature at which served: Pieces were cooked to and held at an internal temperature of 87.8°C (190°F) in a 93.3°C (200°F) oven prior to serving. Hold time did not exceed 15 minutes for breasts and 10 minutes for thighs.

d. Special test conditions: Subjects were given one whole piece of chicken on a prewarmed plate accompanied by 5 hedonic rating cards, each stamped with one of the 5 attributes stated in 1 above. Panelist's instructions are shown on Attachment 1 (page 39).

3. Sensory observations - chicken breasts:

Code 01 - Conventional deep fat fryer

Code 03 - Pressure fryer

Code

01 Medium brown. Typical open fried chicken. Somewhat dry on surface, but moisture entrapped near bone. Completely cooked. Thick portion of breast muscle a little tough. Oil bland. Appearance excellent. Moderately juicy. Meat falls away from bone.

03 Virtually identical in brownness to 01. Uniformly moist throughout. Also completely cooked. Slight stressed fat taste, probably due to entrapment of moisture in oil while unit was under pressure. Meat less tough. Much juicier than 01. More chicken flavor.

4. Sensory observations - chicken thighs:

01 Moderate brown color. Slight stressed fat taste but not objectionable. Very juicy and tender, some sections of muscle still appear reddish, rather than the typical dark meat color. Appearance good. Meat does not fall from bone.

03 As above; tissue seems slightly drier and has appearance but not flavor of undercooked chicken. Appearance similar to 01. As in 01, meat does not fall from bone.

5. Test results:

(1) Chicken Breasts

		<u>Mean</u>	<u>Std Dev</u>
a)	Appearance		
	01	7.3	1.3
	03	7.6	0.9
b)	Tenderness		
	01	7.2	1.6
	03	7.3	1.3
c)	Juiciness		
	01	7.3	1.2
	03	7.5	0.9
d)	Flavor		
	01	7.4	1.0
	03	7.1	1.2
e)	Overall		
	01	7.4	1.0
	03	7.3	1.1

(2) Chicken Thighs

		<u>Mean</u>	<u>Std Dev</u>
a)	Appearance		
01		6.8	1.8
03		7.2	1.1
b)	Tenderness		
01		7.1	1.4
03		7.3	1.1
c)	Juiciness		
01		7.3	1.4
03		7.3	1.4
d)	Flavor		
01		6.9	1.5
03		7.1	1.2
e)	Overall		
01		6.9	1.4
03		7.3	1.2

Statistical interpretation: For all of the 5 attributes above, no significant preferences between open and pressure fried breast or thigh pieces were found at the 95% confidence level.

6. Panelists' comments:

(1) Chicken Breasts

- a. Appearance
01 - Dry, too well done
03 - Dry (2)
- b. Tenderness
01 - Chewy
03 - Chewy
- c. Juiciness
01 - Dry (3)
03 - Dry
- d. Flavor
01 - Lacks flavor (2)
03 - Lacks flavor (2) under-cooked
- e. Overall
01 - Good flavor
03 - Dry

(2) Chicken Thighs

- a. Appearance
 - 01 - Looks dry
 - 03 - Looks dry, soggy, not brown enough
- b. Tenderness
 - 01 - Tender
 - 03 - Too soft, not done
- c. Juiciness
 - 01 - Dry, juicy, greasy
 - 03 - Dry (2), juicy
- d. Flavor
 - 01 - Lacks seasoning (2)
 - 03 - Lacks seasoning (4)
- e. Overall
 - 01 - Dry
 - 03 - Undercooked, soggy

7. Discussion: Consumer observers were requested to indicate their opinions of four specific product attributes as well as an overall attitude for two reasons: (1) to gather additional information to determine whether or not preferences for one of the cooking processes might occur with respect to individual attributes and (2) whether one or a combination of these attributes might be a predictor of overall attitude. Under (1) above, no significant preferences were found for either pressure fried or deep fat fried breast or thigh pieces in any of the four attributes or in overall attitude.

For (2) above, correlation coefficients were run between the four individual attributes and the overall category. Results for both samples of breasts and thighs are as follows:

<u>Attribute</u>	<u>Appearance</u>	<u>Tenderness</u>	<u>Juiciness</u>	<u>Flavor</u>	<u>Overall</u>
Appearance					
Breast	1.00				
Thigh	1.00				
Tenderness					
Breast	0.37	1.00			
Thigh	0.54	1.00			
Juiciness					
Breast	0.23	0.71	1.00		
Thigh	0.43	0.50	1.00		
Flavor					
Breast	0.34	0.55	0.51	1.00	
Thigh	0.37	0.23	0.35	1.00	
Overall					
Breast	0.48	0.75	0.68	0.80	1.00
Thigh	0.48	0.42	0.52	0.83	1.00

As a guideline for interpreting the table, the coefficients, when squared, indicate the proportion of times when one outcome predicts another. In addition, a minimum value of 0.8 is frequently used in data of this kind, since when this is squared, one value would predict another about two-thirds of the time. Thus, for example, Flavor was a reasonable predictor of Overall for both breast and thigh pieces, and this was the only case in which this occurred.

ATTACHMENT 1

PANELIST'S INSTRUCTION CARDS

Eat chicken the way you usually do, whether you pick it up in your hand or cut it with a knife and fork.

You will receive five cards. Each card will have at the top a word describing the product characteristic we wish you to rate. We ask you to proceed as follows:

First card, marked APPEARANCE. Before cutting or picking up the chicken piece, visually examine it and rate your opinion on the scale. Consider attractiveness and surface color in your rating.

Second card, marked TENDERNESS. Cut or bite off a "single bite size" portion. After a few chews, rate your opinion. Consider ease of chewing the meat in your mouth before swallowing.

Third card, marked JUICINESS. With the same or another piece, consider how moist the meat feels in your mouth and rate your opinion.

Fourth card, marked FLAVOR. Rate your opinion of the combination of chicken and breading.

Fifth card, marked OVERALL. Considering the first four characteristics you have already rated, what is your total impression of the chicken?

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APPENDIX E

Human Factors Evaluation

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HUMAN FACTORS EVALUATION

Evaluation of Model A

1. An informal human factors evaluation of the Model A pressure fryer was made while the fryer was cooking as well as during draining of fat from the system.
2. Comments on the pressure fryer are presented below. The comments relate to potential hazards or difficulties that an operator may have with the equipment and are, in part, based upon information presented in manuals supplied by the manufacturer of this equipment. Included are comments about its operation that arose during inspection of the fryer and reading of the manuals.

I. Instruction Card

The instruction card contains statements such as (1) "Close cover and seal before setting timer", (2) "Do not overload", and (3) "Remove and clean cover every third day". Either the instruction card should be revised to include consequences if the instructions are not followed or a reference to the service manual should be included on the instruction card.

II. Service and Parts Manual

a. In general, pre-operating procedures are difficult to follow as written. Accompanying the procedures with additional figures, including one of the entire unit with various components labelled, may clarify the procedures.

b. Because of the potential volume, the cooking oil would require filtering several times per day and this is time-consuming and somewhat hazardous. Cooks may neglect to filter oil as often as recommended.

c. Foot pump ~~may~~ be engaged while the well cover is open causing splattering of hot oil. With fairly large cooking loads of the type anticipated in most Army dining facilities, the foot pump might not be needed and could, therefore, be rendered inoperable. It may also be possible to link the pump to the well cover so that the pump would be operable only when the cover is closed.

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d. Even after well pressure has decreased and the safety lock disengaged, some grease splattering occurs when the cover is opened. This is an undesirable feature of the pressure fryer.

e. The steam pipe leading from the pressure gauge becomes extremely hot during operation and is in such a position that it would be easily and naturally grasped during use of the fryer. The pipe is marked "HOT" only on the back. It should be clearly labelled on the top and the front and a warning included in the safety procedures. It may be possible to insulate the pipe.

f. The temperature control should have a clearly marked $182.2^{\circ}\text{C} - 185^{\circ}\text{C}$ ($360^{\circ}\text{F} - 365^{\circ}\text{F}$) setting, rather than the present $176.8^{\circ}\text{C} - 190.5^{\circ}\text{C}$ ($350^{\circ}\text{F} - 375^{\circ}\text{F}$) interval.

g. A list of operating and important safety procedures should be displayed on a metal plate on the fryers.

h. Cleaning the well after use of the fryer is an awkward process and, therefore, a thorough cleaning job may not be done.

i. The fryer evaluated did not have a built-in filtering system. The draining operation involved placing a metal container at a specific point under the fryer drain, but the container could be misplaced. Some sort of metal device should be installed to retain the container for draining in the proper position. The metal container for draining becomes hot. It may be possible to put insulation on the handles to protect against burning. The manufacturer does supply a built-in filtering system that would reduce the above hazards. It is recommended this system be provided with the fryers.

Evaluation of Model B

1. An informal human factors evaluation of the Model B pressure fryer was made while the fryer was operating and during draining of fat from the system.

2. Comments on the pressure fryer are presented below. The comments relate to potential hazards or difficulties that an operator may have with the equipment and are, in part, based upon information presented in the User's Manual supplied by the manufacturer of this equipment.

Comments:

a. Instructions for operation and warnings regarding use of solid form fat to cover heating coil should be located on a metallic plate on the fryer. The plate should also contain warnings regarding power to coil when coil is not covered with oil.

b. The fryer lid can be opened before zero psig is attained. This may cause oil to splatter on the attendant. The fryer should be designed so the lid cannot be opened until zero pressure is attained.

c. The present thermostat has a temperature range up to 287.7°C (550°F). A thermostat with a maximum setting of 204.5°C (400°F) and smaller graduations should be sufficient.

d. Method of cleaning the cooking well by running hot oil through the hose should be modified to state top of well is to be cleaned by hand and from heating coil to well bottom is to be cleaned with hose.